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ENERGY AND REALITY

II. THE DEFINITION OF ENERGY

WE have tried so far two roads, in order to supplement experience—one, that of independent substances, and the other, that of the idealistic absolute; and both roads have led us to the same goal, the recognition of process as an ultimate fact. We have discovered that "everlasting fixtures," to use Plato's phrase, whether substances or an absolute, will not account for our world. Mass and abstract entities, on the one hand, and perception, on the other, imply "powers" or energies. A thing must be *known*, at any rate, through what it does or can do; it must be defined through its dynamic relations. Elastic balls, geometrical figures, and abstract conceptual entities must be regarded as, at most, convenient shorthand for the ever-restless processes. Although this fact was recognized by philosophy long ago, it is to the actual working necessities of science, from Galileo down, that we owe our present formulation of energy.

But if energy must be regarded as the fundamental fact, what do we mean by energy? It has been customary for the text-books on physics to distinguish between two kinds of energy,—energy as doing work, or kinetic energy, and energy of position or configuration, which has been called potential energy. But this distinction is, after all, merely relative; potential energy is active, too, but in a different way. Whether we shall call energy active or potential depends merely upon our purpose. A body can not be in a certain position without certain energetic interactions; and these are just as real energy as that brought about by the fall of the body. Ether waves may be regarded as potential light sensations, but they symbolize, for all that, actual physical energy. All energy, therefore, does work or is active.

But what do we understand by doing work? This as ordinarily used is not a simple concept, but involves, besides energy, time and space. We must, therefore, try to find a simpler formulation of our concept. In doing work, moreover, is one energy really transformed into a different energy? Take chemical changes as the condition of electricity, or food as the condition of mental energy, can we say here that one form really *produces* another form; that the chemical changes *become* electricity, and food-stuff mind stuff? This, at least, would be difficult to prove; and we must be content for scientific purposes to treat one set of processes as the describable conditions or antecedents of another set of processes. Somehow one set of processes do connect or become confluent with another set. The phenomenal conditions are not the whole story, but they are *our* story, except when we deal with transitions within experience itself. The antecedents may or may not be the same in kind as the consequents; and, as in many cases standards applicable to one set of processes are not applicable to another set, we can not very well speak of identity of energy in such cases. In the case of chemical energy, for example, mass and weight are applicable, but these have no relevancy when it comes to electricity or conative energy. One of the great stumbling blocks in the past to a thorough conception of the energetic wholeness of nature has been the difficulty of imagining how molecular motion could *produce* feelings and volitions. It is this difficulty which leads Clifford and others to espouse the meaningless doctrine of parallelism. But we appreciate now that the difficulty of production would be about as great in molecular motion producing electricity. Hence the old difficulty appeals to us less. Parallelism of facts or energies would mean that one set of energies could make no difference to another set. Parallelism to our purposive energies would, therefore, mean absolute ignorance. And, on the principle of parsimony, or any other sensible principle, we would have no right to assume such energies. All that is needed, however, is that we should have describable conditions, or that one set of processes should make a predictable difference to another set. If processes in their sequences satisfy certain expectancies, or have such uniformity as enables us to adjust ourselves to the future, that is the only conception of energy with which we are concerned. The possibility of ultimately simplifying energy into one form we shall deal with later.

If we define energy, with Lotze, as determinate position, we must not forget that energy involves happening, that it is fundamentally process. Lotze strives hard to get rid of space or externality, and to reduce the energetic positions to phases within a spiritual whole, to a polyphonic esthetic unity. With a conception of energy which strives to get rid of energy, we are not here concerned.

It will appear on closer scrutiny that the concept of energy is a dual concept involving *process* or stuff, on the one hand, and *constancy* or *uniformity* of processes, on the other. This has sometimes been ignored, and it has been supposed that mere constancy exhausts the concept.[1] It we look at the process side, we find it convenient to recognize qualitative differences of processes. Chemical processes, for example, are different from neural; and again, among chemical processes we must distinguish some seventy or eighty elements which so far have remained irreducible to each other. Take the mere field of sensations, and we must distinguish some fifty thousand different processes. If we look again at the constancy aspect of our concept, we must not regard this as a mere subjective habit, with Hume, or a category of substance, with Kant; but we must regard the relative uniformity of processes as real as the processes themselves and inseparable from them, forced upon *us* and not upon the processes. It will be apparent now that the concept of energy is a very complex concept. We can only hope to offer the most provisional kind of definition. Let us lay it down, then, that energy is such a uniformity or constancy of processes as makes prediction of the behavior of things under definite conditions possible. As our knowledge of the external world depends upon perceptions, we may say that nature consists of such predictable processes as can appear in our actual or possible experience.

That does not say that energy is nothing but perceptual uniformity, but only that we are dependent for our immediate data upon such perceptual processes. Hume is right, as over against Berkeley, that we must assume "powers," and not mere perceptual qualities; but he is not right in calling these altogether unknown "powers." That depends upon what we mean by knowing and the powers we are talking about. The powers, to be predicated at all, must be capable of making differences to other "powers" under certain circumstances. Among these are the differences they must make to our own human nature. We can know these powers, in some sense, at least, viz., in so far as they react upon each other and, most important of all, upon our psychophysical organism. The real must *seem,* in order to make science at all possible. In the case of nature processes, however, we must be satisfied with a knowledge of their external continuities, with the differences which they make *to us;* we can not have access to their own inwardness. This is only possible in the case of conscious beings like ourselves. The inner reality of energy is not something we can sense, but something which must be acknowledged. The inner significance of the process must be furnished by the constructive imagination—using the sense energies as signs and tests in its ejective procedure. It is anthropomorphic, in the worst sense, to suppose that our strain and resistance sensations from joints and tendons can be read into the objective processes of nature. All we can say about nature is that certain rearrangements appear to us in certain ways and can be predicted and, to a certain extent, controlled by our wills. It is in our consciousness of fulfillment of purpose that energy becomes a real activity and not a mere artificial piecing-out of what goes on behind the scenes. In our own purposes the reality of the process is revealed to us first-hand; the rest is interpretation and conjecture.

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[1] This seems to be the idea of Poincaré in his brilliant book "Science and Hypothesis." See especially p. 132 (English translation, 1905).

But is energy anything more than a collective name for those uniformities or describable conditions which can be established through experience? The passion for simplification is one of the deepest and most universal passions of human nature; and there always will be a tendency, no doubt, to find some *Urstoff* in terms of which all this variety of process can be expressed. And so we have our vortex hypothesis; our atomic hypothesis; the various spiritualistic hypotheses, such as the will theory of Schopenhauer; and the more modest agnostic attempts, such as the double-faced unknowable of Spencer, which is truly void of expression in both its faces, the physical and the psychological, stolid as an Oriental. The history of philosophy and of science, from Thales down, might almost be written in terms of this quest for *Urstoff*. We have substituted, to be sure, energy for substance; but have we really simplified matters so far as finding an identical basis is concerned? Does not the fancied unity of energy break into pieces in our hands, as much as the older theory of substances? Have we not been misled by the *name* of energy into supposing that we have discovered real identity? When we fancy that we have identity, have we not introduced additional determinants to meet the variety of facts, and is not the real complexity as great as before?

This, at least, seems to be the case with the motley array of energies with which Ostwald entertains us.[2] I can see no unity here except the name on which all the Protean types are strung. We must at least find a more fundamental unity than a mere term can furnish. Do energies all do work? Very well, it is through the *difference* of the work they do or through the difference of the effects which they occasion that we know them or identify them. Ostwald has, after all, succeeded in saying nothing more than that one set of changes, under certain conditions, is followed by another set of changes. He has said nothing about the real nature of the processes; his energies are nothing but classifications of expectancies, an enumeration of various types of uniformity. The best he has done is to emphasize that one set of processes can make a difference to another set of processes throughout the whole scale of cosmic changes; but his whole account deals merely with the phenomenal side of the processes, not with the metaphysical side. This is nowhere more apparent than in his absurd attempt to deal with purposive experience as a derived or composite type of energy. We shall recur to this later.

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[2] W. Ostwald, "Vorlesungen über Naturphilosophie," 1902; also "The Philosophical Meaning of Energy," *The International Quarterly*, Vol. VII., p. 300.

When it comes to establishing the number of kinds of energy or the identity of energy, we must proceed, not by *a priori* assumptions or mere esthetic predilection; we must fall back upon the pragmatic test, viz., How many kinds of energy are needed to account for the diversity of our facts? Simplification and the discovery of greater diversity here have gone hand in hand. While successful in reducing light and magnetism to the category of electricity, new phenomena in the way of radioactive substances have appeared. Only one universal formula can so far be laid down with any degree of certainty, viz., that all known energies are capable, under describable circumstances, of making a describable difference to each other. In this sense the universe may be said to be energetically one.

In the attempt to simplify energy, two forms of cleavage have been particularly obtrusive. Perhaps the greatest drawback to the simplification of energy has been the distinction between physical processes, on the one hand, and conscious processes, on the other hand. It has rightly been insisted that the generation of consciousness from non-conscious processes must be an ultimate mystery. This objection to the energetic continuity of the world, if not its identity, I have tried to remove in another paper on "Consciousness and Reality."[3] In this I have tried to show that consciousness is not a form of energy, but must be regarded as an independent fact or dimension of reality; that the difference which consciousness makes, namely, that of awareness, does not involve any variation in consciousness, but in the complexity of the energetic conditions; that psychic processes, therefore, as processes, can make differences to other processes and can vary with them, quite irrespective of consciousness. To avoid misleading associations I have called this psychic activity conative energy, which, it will be recognized, may be either conscious or unconscious, may be either tendency or meaning, according to the conditions. While such a theory has nothing to do with deciding the question of an ultimate *Urstoff* or identity of energy, it does take away the greatest conceptual obstacle to energetic relations. It may still remain true that conative energy is fundamentally different from chemical or electrical energy. Physical energy still remains an *X*, so far as its inside is concerned, and does not become psychological processes. We may know a great deal about its workings, its predictability, and manipulation, but we know nothing first-hand about it. It is only a name for certain constancies or uniformities of perception, which make prediction possible; but our knowledge of it to the end remains phenomenal. This *X* we may divide into *X*'s according to convenience, in dealing with the perceptions and uniformities of nature. Thus it may be convenient to treat the *X* which manifests itself to perception as mass and weight as different from the *X* of electricity, to which mass and weight are not even phenomenally applicable. How many *X*'s we need, how many types of constancy, must be determined in the process of the adjustment of our purposes to the larger world.

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[3] This JOURNAL, Vol. V., p. 232.

The other great obstacle to simplification has been the cleavage as between energies where mass and weight can be applied as measures, as in the case of mechanical and chemical processes, and energies where no such units can be applied, as in the case of electrical and nervous energy. The vigorous attempt to bridge the gulf between mass energies and electrical energies we have referred to in our discussion of mass.

The brilliant work in regard to the atom by such men as J. J. Thomson, Rutherford, and others shows that atomism is not a dead issue, but is still to be reckoned with. You can not brush aside atomism by the mere dogmatic wave of your hand to the effect that reality is one and undivided, as has been assumed in Spinoza's "extension," Schopenhauer's "will," the Vedānta "self," and other poetic efforts. Such questions can be settled only with reference to the demands of experience; and the success of atomism must depend upon whether it can be shown to have a basis in facts.

But there is little in common between this present atomism of the electrical school and the old atomism. In the new atomism energy has become the chief interest rather than mass or weight, and it has been confidently asserted that these can be reduced to motion and distance. The atom is no longer regarded as eternal and indifferent, but is the storehouse of pent-up energy of enormous quantity, though, as in the case of radium, it may be in a very unstable equilibrium. Instead of extended bits, we have now to deal with electrical charges of a positive and negative kind, although it may still be convenient to speak in terms of particles or corpuscles as vehicles of charges. Instead of the mythological "bonds" of an older chemistry, we have the relation of these positive and negative charges to each other, the former accounting for the relations between the charges within the atom, while the latter, being more diffuse, account for the form of the atom as a whole. Atomic relations are explained by the fact that atoms can, under certain conditions, receive or expel particles, in the former case increasing their negative, in the latter their positive, charge. By means of this electrical atom and its simpler unit, the electron, which bears very much the same relation as regards distance to the gross atom that interstellar masses bear to each other, the electrical school strives to find a common unit which, through the stability or instability of its component electrons, can account for the scale of physical changes from the ordinary chemical elements to the strange behavior of radium. And it has even been suggested that nerve energy and mental energy are "inductive" relations and can be reduced to electrical phenomena. Thus this school feels that at last the old dream of one ultimate *Urstoff* has been attained. We have, instead of the old mechanical pluralism of the atoms of Democritus, with their dependence upon mechanical contact, a new energetic pluralism which is capable of constituting its own continuum over intervening distances by means of energetic charges, whether within or outside the gross atom of chemistry.

The reason given for the attempt to simplify all matter and energy into terms of electricity has been stated to be that we know something about electrical energy and its relations, while we are ignorant of other kinds; hence the economy in reducing them to electricity. This assumption may well be doubted. To be sure, we have learned a great deal about manipulating electrical energy, but do we really know what electrical energy is? If not, how are we any nearer an explanation? In speaking of mental energy, moreover, as sustaining inductive relations to others, or being radioactive, are we not dealing merely with metaphors of a very questionable kind? I have already referred to the interesting analogies pointed out by Thomson as between the figures assumed by magnets in an electrodynamic field and the periodic law of the elements. But after all, is this anything more than an analogy, however ingenious it may be? Would energies necessarily have to be identical in order to obey the same mathematical laws? As regards the different conductivity of different elements, would this prove, any more than disprove, an electric substrate? Does a man carrying a log necessarily have to be a log? Is not the electrical theory another attempt to reinstate the dogmatic principle of Empedocles, that all action must necessarily be that of like upon like? I can see no reason for admitting any such *a priori* assumption in whatever scientific disguise. For empirical purposes, at any rate, we must recognize ultimate chemical elements and other divisions of energy without thereby prejudicing interaction. And to reduce mental processes which we know to electrical charges which we do not know is not very illuminating.

The doctrine of *Urstoff* may, after all, be a mistake, a running after a *fata morgana,* a search for the philosopher's stone. It is, at any rate, simpler to assume as many energies as the difference in dealing with the facts makes convenient, and we can not deal with a stone or a mind as though it were electricity. Connecting with a stone or a mind does not produce the same consequences as connecting with an electric current. Even if the characteristic properties of matter, mass, and weight can be reduced to motion and distance, or if the mechanical atom can be regarded as only a half-way house for treating a fact which really consists of electrical charges with their particular and constellation velocities, it still remains true that mass and weight *are* determinants which electric currents do not possess; and it will still be convenient to acknowledge them for descriptive purposes. What we need for epistemological purposes is not *one stuff* or identity of energy, but the possibility of one energy, under statable conditions, making a difference to another, whether of the same kind or not. And so much at least seems clear from present scientific advance. To what degree we can acknowledge identity we must leave to the progress of science.

If we are to start with the known and work from this to the unknown, there is only one place where we can start, and that is with purposive or conative energy. The mistake made by the distinguished physical scientists referred to is in supposing that we do know material energy, especially electrical, and that we can work from this into other realms of energy, including, perhaps, conative. As a matter of fact, the only form of energy of which we know anything first-hand is purposive energy. If we are to simplify, if we are to attempt any form of monism, here would seem to be the place to start, for, on the one hand, this is the only form of energy of which we have immediate awareness; on the other hand, we know this in an indefinite number of stages of complexity, while our knowledge of electrical energy is conjectural at best. We might, too, no doubt, accommodate our mathematics to such a theory of the fundamental nature of things. There would be, for mathematical purposes, nothing more absurd in treating things as made up of conative tendencies than as made up of electrical charges, inasmuch as mathematics in any case is indifferent to the metaphysical stuff of things. And inasmuch as all energies, to be known at all, must make a difference to mind-stuff or our reflective purposes, such simplification would be the only logical working-out of the principle that all action must be of like upon like. It would not be necessary, moreover, to regard this mind-stuff as feelings, as Clifford does; or as perceptions, as is done by Leibniz. Feelings and perceptions have no meaning apart from consciousness, and we have shown earlier that the larger part of our mental constitution must be unconscious, so far as we know, at any one time. Conative tendency, therefore, as it is the most basic fact of our mental life, affords the additional advantage of not being necessarily associated with consciousness. It is for psychology to describe the laws and sequences of this process of conation, leaving it to philosophy to correlate this energy with other energies of nature. It is not the business of psychology, any more than of any other science, to falsify what it finds, but to give as true an account as it can under the limitations which it sets itself. And such sequences and connections as it sets itself to deal with must in so far be true sequences and laws.

All the interesting speculations which energy admits of elsewhere will be equally available here. Does mind-stuff, for example, act at a distance? Is it radioactive in its nature? Can we account for mass on the basis of non-extended sensations with their simultaneous and successive fusion. Is it, like some other subtle energies, an energy which this earth can scarcely hold? Is it limited to certain neural conditions for being caught and manifesting itself? Here, as in the case of other conceptions of energy, such questions must not be settled *a priori*, but on the basis of evidence. We might take advantage of interesting analogies, at least, from recent science as regards action at a distance. Perhaps there may be relations between mind and mind analogous to wireless telegraphy, as contrasted with the grosser methods of ordinary perception with its end-organs and nerve wires. And not only might we find illustrations of such telepathic connection in the out of the way facts of psychical research, but the social consciousness itself, with its high degree of suggestibility and its sense of companionship and unity, might be the most striking instance of such telepathic action, not to mention the sense of divine presence of which the mystics have made so much. We can not, at any rate, be said to have settled all the possible forms of interrelationship of mind to mind, and there may be subtler ways of connecting up mind centers than have been dreamt of in man's past philosophy, and they may be ways nearest home, too, and not merely pathological; in fact, while we know a great deal more about the inwardness of mind-energy than electricity, we know far less of intersubjective connections than of electrical connections. To use telepathic relations, however, for all psychic interactions, misses the whole point of the distinction, as using radioactivity in such a sense as to make all substances radioactive misses the whole point of the concept of radioactivity, because in case of such a generalization we would still have to hold that different substances are radioactive or telepathic in very different ways, thus bringing the distinction in through the back door. As regards accounting for mass, again, the mind-stuff theory could probably make as plausible a case as the electrical. We have seen how the sense of mass varies with filling and movement in the case of both visual and tactual sensations, and how it can be generated by velocity in the case of sound. And as for analogies, without respect for evidence, the panpsychists no doubt have the electricians beaten. Behavior, resembling sensitive behavior and even purpose, has been pointed out, not only in the case of organic structures, but in the reactions of inorganic structures, such as the striking phenomena of the chemistry of crystals. Analogies, therefore, would not be lacking on the psychological side.

Whatever poetic charm such a theory of mind-stuff has, it does not help us one whit in meeting the variety and stages of process; and while we must insist that there can be no simplification or classification which does not take into account and make central our purposive energies, yet it does not follow that we can regard reality through and through as purposive energy. We would have to introduce differentia, which would make the supposed voluntaristic substrate a mere word without real meaning. If the materialist has been wrong in reading up, the idealist may commit the same mistake in reading down. So far from this reading down ensuring the place of mind-energy in the universe, it would dissipate its meaning and make spiritual energy indistinguishable from material energy, as in either case the lower will be identical with the higher. This is equally true of Spinoza's "thought," Hegel's "absolute," and Schopenhauer's "will." The failure of materialistic and spiritualistic monism is essentially the same—the failure to discriminate and to meet the differences that we must meet in adjusting ourselves to a universe such as ours, with its complexity and multiform stages. Materialism has been at least as extravagant in its play of imagination as spiritualism. Natural science with its Faraday tubes, its atomic bonds, its affinities and its repugnancies, its thread theories, etc., can at least rival Hegelianism in the realm of fiction. It is safer to stick to the facts and to insist upon spiritual energy where we find evidence of spiritual energy; and at the same time follow the lead of the facts in insisting that spiritual energy can make a difference to the simpler forms of energy, and they to it, whatever in the last analysis these simpler forms may be. All the facts go to indicate continuity within our world; but that is a different thing from identity. About the metaphysical nature of the simpler forms of energy, we must confess ourselves agnostics, however skilful we may become in their phenomenal prediction and manipulation.

One thing is certain, and in this spiritualistic monism will always have the advantage over any material monism, that purposive energy is the *Urstoff* so far as knowledge is concerned. This purposive energy can not be analyzed or decomposed into sensations, as some have supposed, for sensations themselves are the artificial products of analysis, the abstractions of this purposive will for its own ends. For the will, therefore, to resolve itself into sensations would involve a hopeless circle, a deliberate suicide. With reference to our conative tendencies, the variety of the world, spiritual or material, must be differentiated and systematized. Whatever scheme of stuff we adopt in the end, it is, after all, merely a spreading out of our world for the convenience of the purposive moment. Nothing could be more absurd, therefore, than to regard this purposive energy as an epiphenomenon or as derived in any sense from other energies. On the contrary, our purposive meaning is the only thing which can be known as final. The consciousness of what we are, when we can take account of our own stream of processes, is the only first-hand access to the inwardness of reality. The unity and reality of this purposive moment, therefore, must be regarded as its own vindication. Doubt it and you none the less vindicate the reality of this activity, which can set its own problems and, in a measure at least, solve them. It is this unity of meaning which furnishes the indispensable condition for such coherency and system as we, finites, are able to discover. To make this fundamental insight of conscious experience itself a derivative from chemical changes, shows, on the one hand, a complete ignorance of psychological analysis from Augustine and Descartes down; as it shows, on the other hand, the dogmatic bias of men who, like Ostwald, work in a certain physical field, forgetting that the laws and the unity of the very energy they seek must, in the first instance at least, be the shadow projected upon nature by the reflective moment. This furnishes the undying inspiration for the search for the unity of things.

Modesty, as regards assumptions, would seem to be the final word both as regards the natural scientist and the philosopher. Let us not be misled by the passion for simplicity into supposing that wherever there can be interaction or where one energy can make a difference to another, there must also be substantial identity. Let us be thankful for the brilliant advance in science, which has reduced such seemingly disconnected fields as light and magnetism into terms of electricity; but let us stick close to the facts and acknowledge such differences in the nature of things as the facts demand. Only in this way shall we have workability of hypothesis. The rest is the poetry of science, interesting amusement for the idle hour—sometimes, perhaps, prophetic of greater victories to come.

For classificatory purposes we might, perhaps, group the different energies into three fundamental groups: material energy, where mass and weight are applicable; electrical energy, including magnetism and light, where we can not apply standards of mass and weight, but where we have less stereotyped conditions; and conative energy, which, like electricity, is immaterial, but which can become self-directive, can have meaning and value. This, however, is merely a convenient classification. It is no causal cleavage, preventing these energies from interacting in nature and forming to that extent one energetic whole.

Such questions as whether there can be action at a distance; whether the cause must be identical with the effect in kind and in time; whether all energy is radioactive; whether the universe can be such a one-way affair as indicated by the second law of thermodynamics,—these questions can not be settled *a priori,* but must be determined by the needs of human experience. I have already indicated the advantage of saving such terms as radioactivity for specific groups of facts. I can not resist the temptation of offering a suggestion or two in connection with the other problems indicated. If we eliminate the contradictory concept of ether, the present status of science would seem to indicate action at a distance; even amongst the electrical charges of the atom we must conceive distances comparable, considering the apparent masses involved, to the distances of interstellar space. No intelligible conception of energy has been able to avoid a certain discreteness of centers; and any medium invented must break up into discrete reactions in order to account for our actual world. There would seem to be no reason, moreover, why space, with its free mobility, should offer any other limitation as regards energetic interconnections than that involved in distance. We seem to be driven, therefore, to an energetic unity of the universe rather than to a one-block theory in order to account, at the same time, for its seeming continuity and diversity.

As to the question of cause and effect, I think I have indicated sufficiently that in order for one set of changes to give rise to another set of changes there is no need of their being identical. Chemical changes do seem to give rise to nerve changes, nerve changes to conative processes, without any need of supposing that bread-stuff is mind-stuff. But we can no more assume that cause and effect must be identical in space and in time than in kind. As I have already said, there would seem to be indications of action at a distance; and if this is the case, there must also be a difference in the time of the cause and the effect. Let us leave out again the fictitious ether, which, in the words of Poincaré, "if it is able to explain everything, this is because it does not enable us to foresee anything; it does not enable us to decide between the different possible hypotheses, since it explains everything beforehand. It therefore becomes useless."[4] Take, for instance, the connection of a charge from one electron to another. "The perturbation is propagated with a finite velocity; it, therefore, reaches the second electron only when the first has long ago entered upon its rest. This second electron, therefore, will undergo, after a delay, the action of the first, but will certainly at that moment not react upon it, since around this first electron nothing any longer budges."[5] To use a more concrete illustration from the same author. Take a Hertzian oscillator, like those used in wireless telegraphy: "If all the energy issuing from our oscillator falls on the receiver, this will act as if it had received a mechanical shock, which will represent in a sense the compensation of the oscillator's recoil; the reaction will be equal to the action, but it will not be simultaneous; the receiver will move on, but not at the moment when the oscillator recoils. If the energy propagates itself indefinitely without encountering a receiver, the compensation will never occur."[5] I will not enter into the intricacies of mathematical science; but one thing seems certain, that the question of the relation of cause and effect can no longer be settled *a priori,* but must be settled by experimental evidence. To say that the cause *must* be identical with the effect is as unscientific as that the heavenly bodies must move in circles, these being the most perfect figures; or the universe must be a sphere for the same reason.

As regards the theories of a one-way process of the universe as a whole, which is implied in the second law of thermodynamics and in Spencer's famous formula of evolution, as a passing from the homogeneous to the heterogeneous, with the corresponding dissipation of motion, I can not help thinking that the ancient Greeks, in spite of their inferior tools, show a superior imagination. Any theory of the universe based upon a one-sided process, such as the degradation of energy, must assume a finite creation or beginning, in some way; for, if the universe as a whole has no beginning, then any finite process, such as the second law of thermodynamics indicates, must have run its course countless ages ago. The universe must have become stark still; all matter must long ago have become integrated with the corresponding dissipation of motion. The logic of such a theory was long ago expressed in the words of Empedocles: "For if they (the elements) had been passing away continually, they would not be now."[6] Such generalizations, therefore, we must regard as

[4] *Popular Science Monthly,* Vol. LXX., No. 4, p. 348.

[5] *Ibid.,* p. 347.

[6] Line 90, Burnet's translation.

one-sided, though useful makeshifts, considering our ignorance of the total process. That the running-up process may be going on in connection with a running-down process, that motion may be converted into heat, and heat converted back into motion, seems to be illustrated by the recent discovery of the Brownian movement. This may at least serve to break through our scientific dogmatism.

To describe the real world, moreover, with its interactions and its history, we need more than energetic constancies. It is a mistake to suppose that *being,* which we have seen must be understood as processes, is the only attribute of reality. We need space and time, as these processes vary with the time and the distance and are unintelligible otherwise. Without time and space, energy would be congealed—frozen process. We, therefore, must add these as additional dimensions or independent variables of reality. We also must add consciousness as a dimension, since at least part of the behavior of things is conscious behavior, and we have found it impossible to derive consciousness from the non-conscious or to state consciousness as energy. Reality, also, in its motley complexity of changes must possess direction, must have a certain objective form; else all meaning and validity become impossible. This objective form must determine the permanent worth and survival of the finite forms or purposes, individual and social, which arise in evolution. And if they fail to conform or fit in, we may suppose that they are destroyed as forms and that the energies which they held are thrown again, to use a figure from Ibsen's "Peer Gynt," into the ladle of the button moulder to be fashioned into new forms.

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ORGANIC SENSATION AND ORGANISMIC FEELING

THE psychology of attitude is at last getting its right of way. Atomism and psychical chemistry are going the way of mental faculties of the pigeonhole order. Even the biological fashion in our science, useful as it is, must subordinate itself to a psychology of character, a psychology of the whole man. And the study of mental attitudes, trends, tendencies, and the like, will help us to combine "structural" and "functional" and all the other interesting abstract phases of individual unitary character.

In the light of present psychological thought, first-hand accurate data about changing and conflicting mental moods should not come amiss. Hence the following slight study of moods, caught in the act of conflict and change, ought to have a representative value.